Biometric Systems
– Threats and Countermeasures
– The State-of-the-Art

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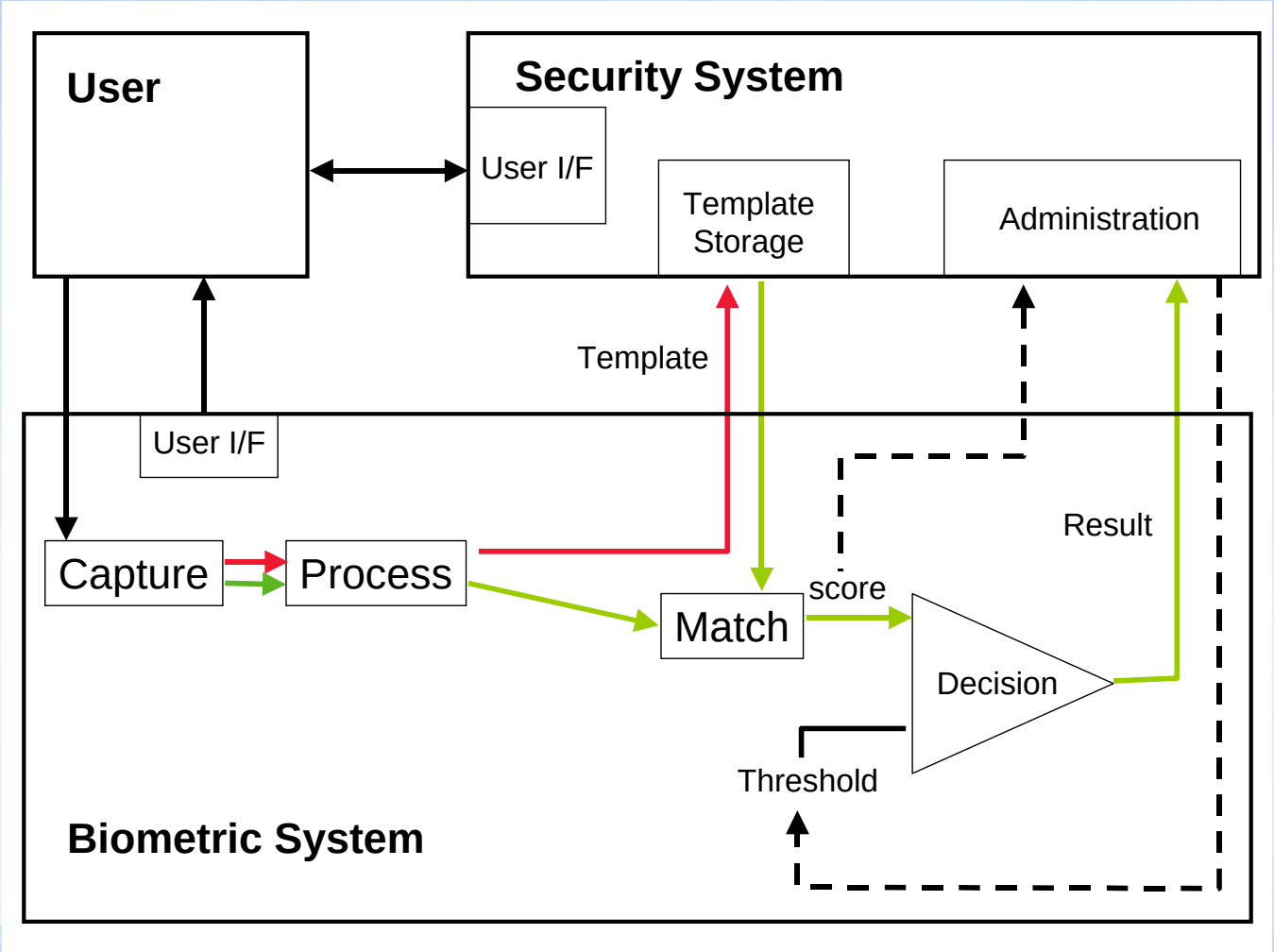
Overview

- General Biometric System Security
- Security of Biometric Templates
- Security Architecture
- Fake Finger Rejection
- Mutual Authentication

Biometric System and Security System Interface



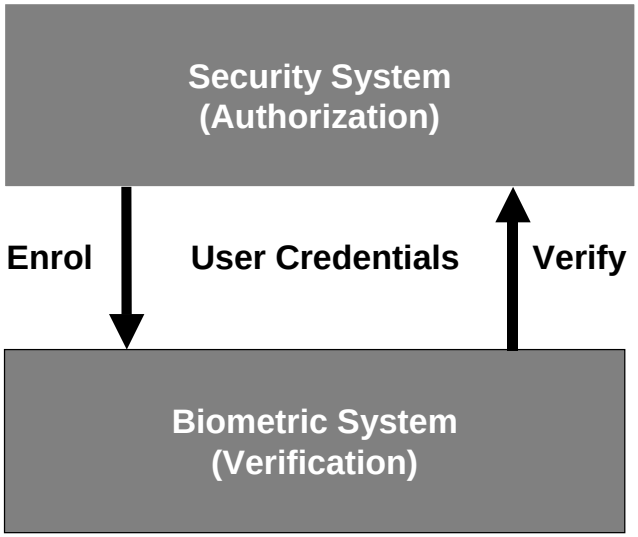
Enrollment/Registration of Individual

- ***registration*** of a new user within security system
- administrator of the system determines the unique ***identity*** of the individual
- new ***user*** established
- a unique ***identifier*** is assigned to the user by which they are known to the security system
- individual instructed to ***enroll*** their biometric to create a biometric ***template***
- template ***bound*** to the identifier, to create a ***user record***

Verification/Authorization of User

- individual establishes a ***claim*** to the system
- user record is ***unbound*** to produce the template and identifier.
- individual is requested to ***verify***
- if a successful match occurs, the identifier is relayed to the security system
- user is ***authorized***, according to their security system rights and privileges

Biometric Verification/User Authorization - User Credentials



- Link between user verification/system authorization
- Provides complex answer
- Individual can have a number of user credentials
- Prevents Identity Theft

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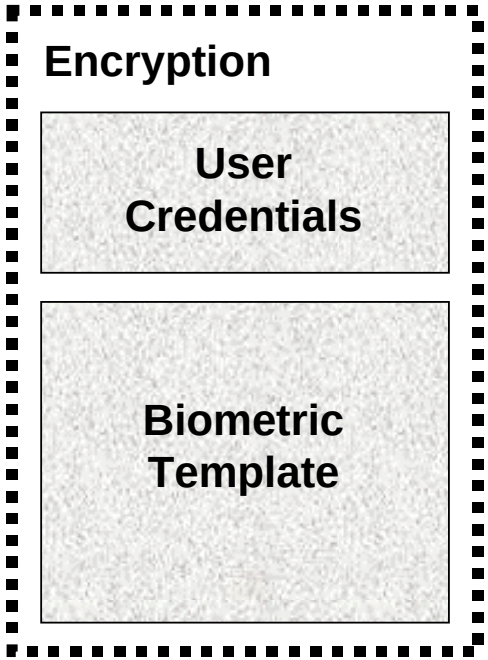
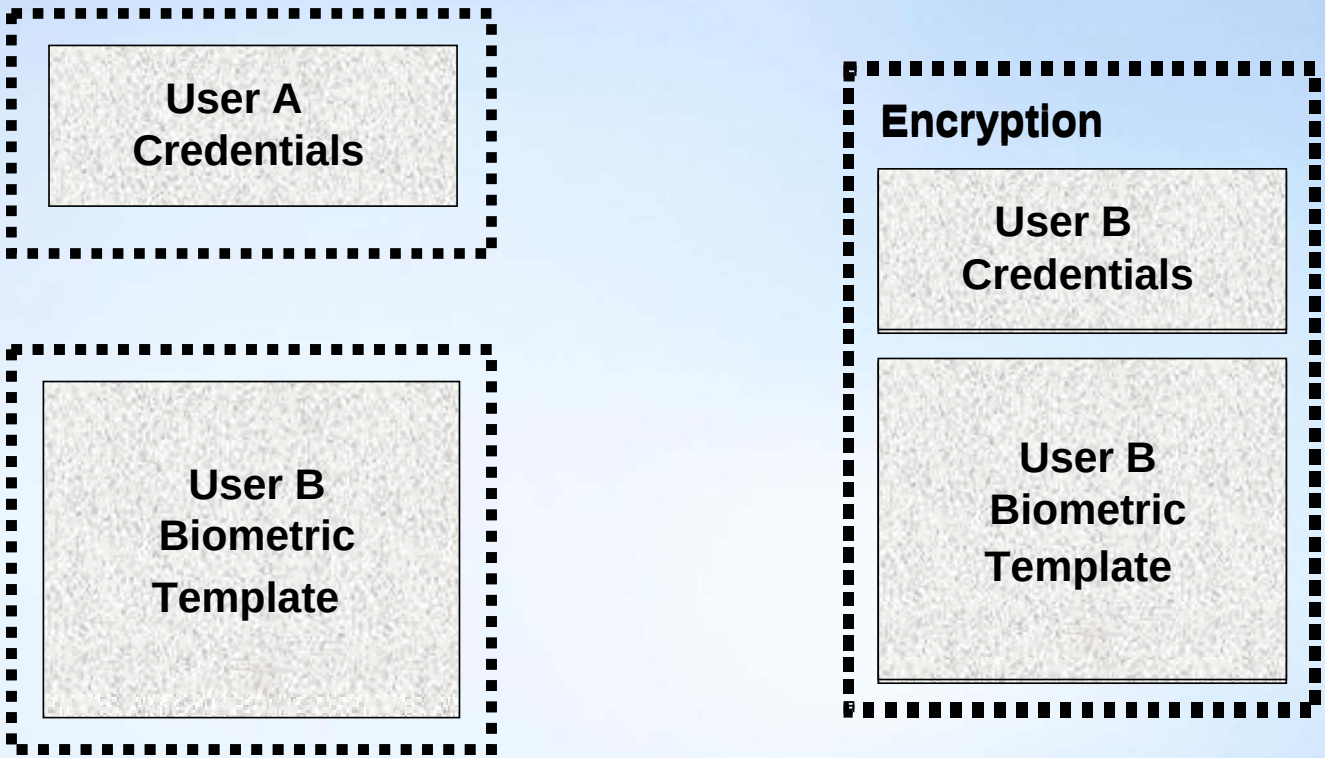
User Record - Encryption



User Record – Encryption
Prevents Identity Theft



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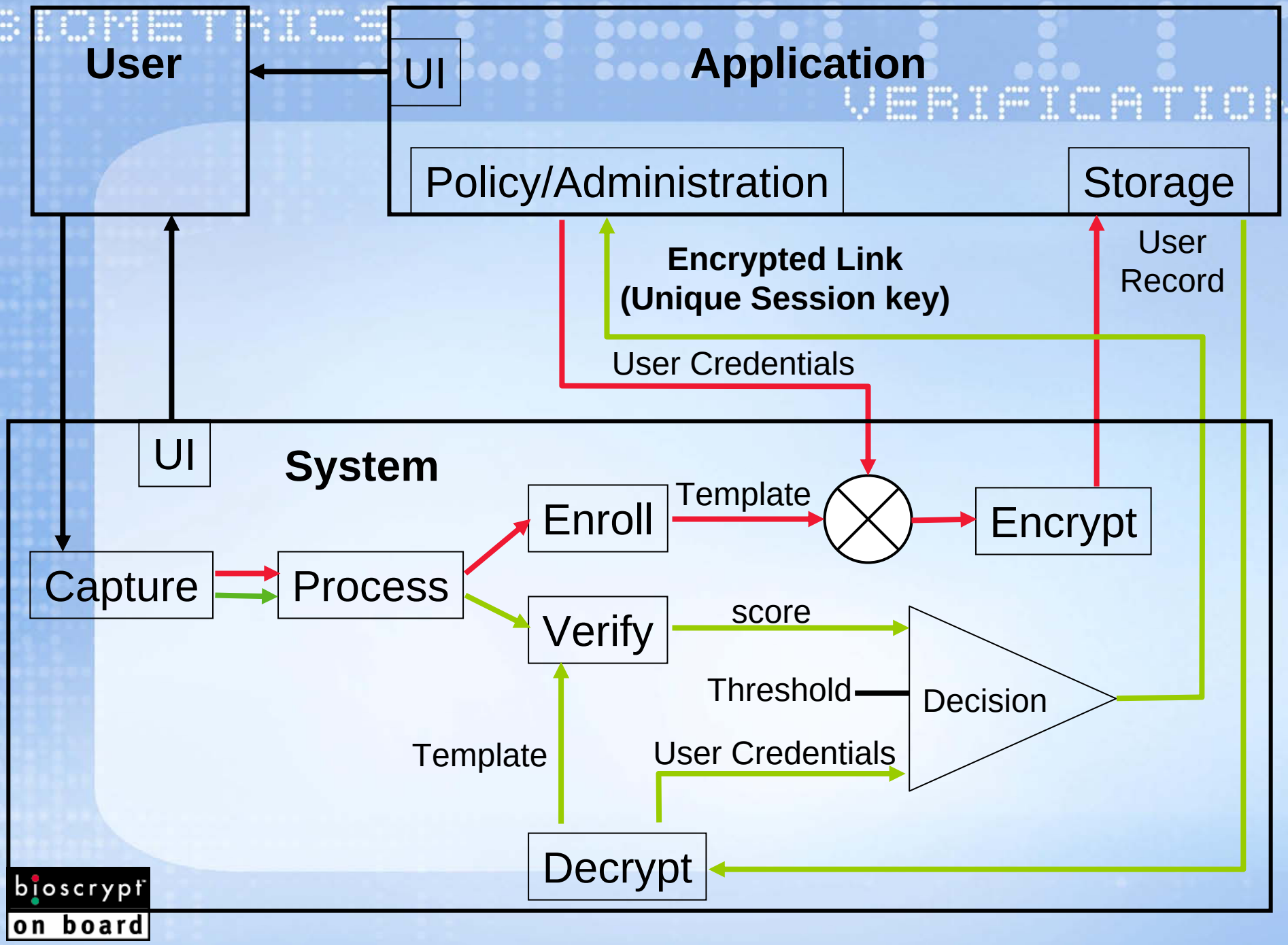
User
UI
Application
Policy/Administration
Storage
Encrypted Link
(Unique Session key)
User
Record
User Credentials
UI
System
Enroll
Template
Encrypt
Capture
Process
Verify
score
Threshold
Decision
Template
User Credentials
Decrypt
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System Features

Encryption of User Record

- Provides Confidentiality and Integrity of the biometric template
- Mitigates Identity Theft.

Unique Session Key

- Mitigates replay attack

Use of User Credentials/Identifier

- Mitigates attack on the biometric system result

Internally set threshold

- Avoids threshold-based attacks

Security Evaluation - Common Criteria

- Established in 1998 to provide a mutually recognizable basis for the evaluation of IT security products.
- Designed to replace the existing National Body schemes for security evaluations.

- The Common Criteria comprises three components:
  - Common Evaluation Methodology
  - Protection Profile
  - Security Target

Other System Issues

- Controlled Enrollment/Registration
- User Record/Encryption
- Liveness detection
- Mutual Authentication between components

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The Power of Touch

Overview / Contents

- Context of this discussion
- Interlocked component security architecture
- Real-biometric discrimination – Anti-spoofing
- Mutual authentication between components

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Context for this discussion

- Assumptions
  - Platforms may not be secure
    - Use “Trusted Platform” resources if present
    - Provide best reasonable trust levels when “TP” not present
  - Networks may not be secure
  - Components and their interfaces (SW & HW) can be made reasonably secure
- Approach
  - Balance the security of the ID system with the security of the rest of the system
  - Use interlocked component security chains
    - To provide reasonably secure system-level functions
    - On unsecured platforms and networks

Client Platform

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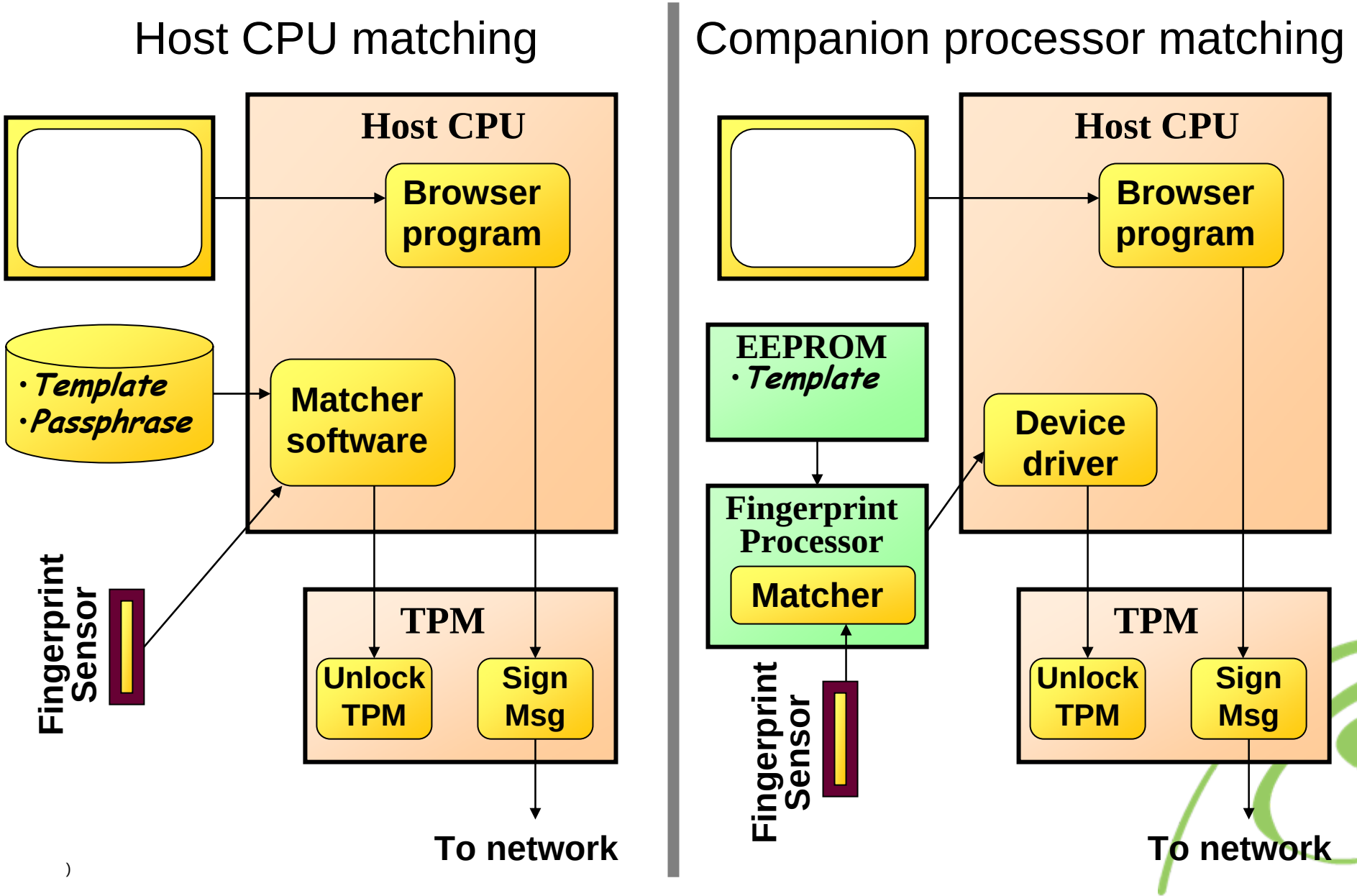
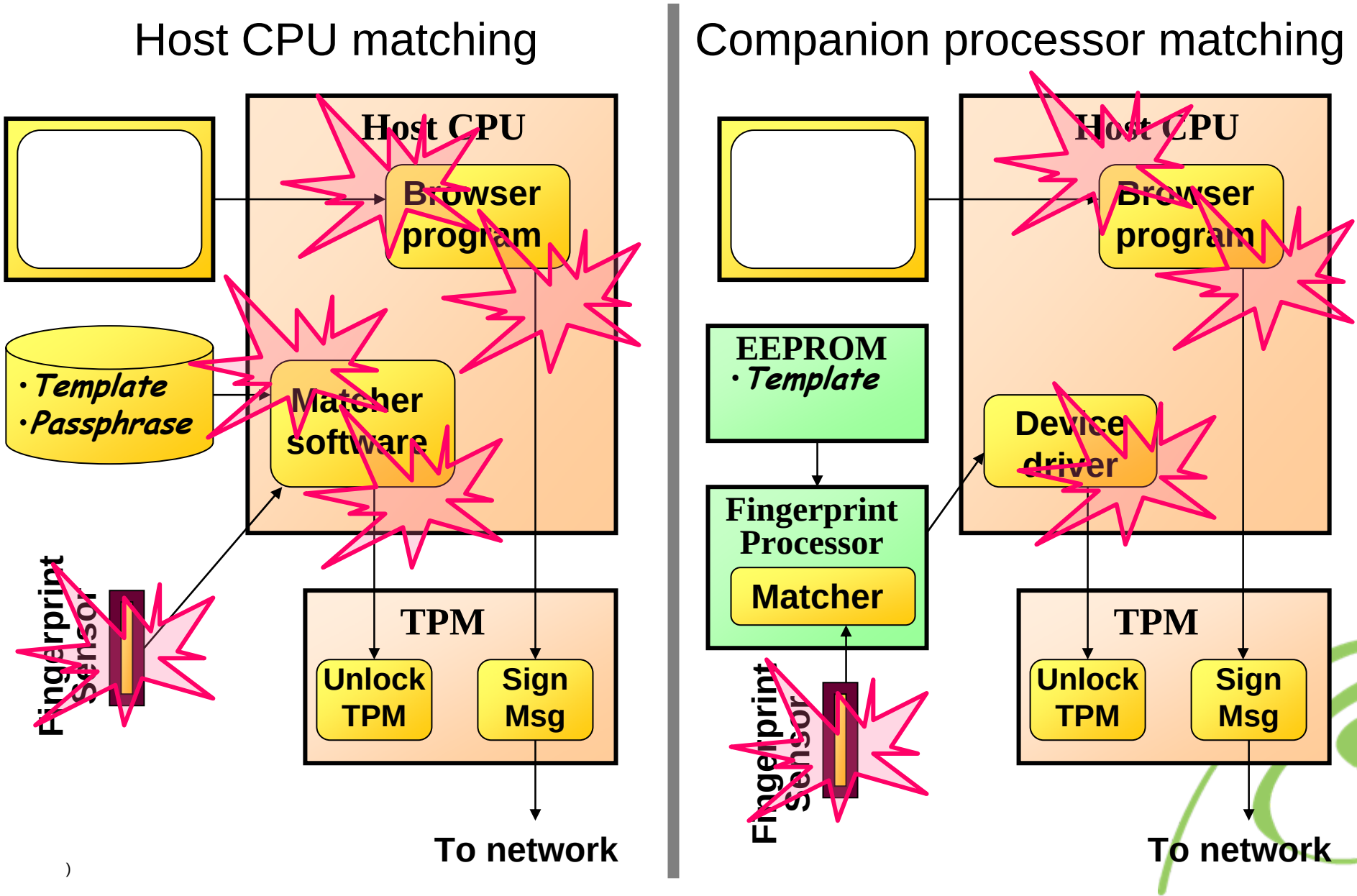
A simplified architecture comparison



Some possible attack points



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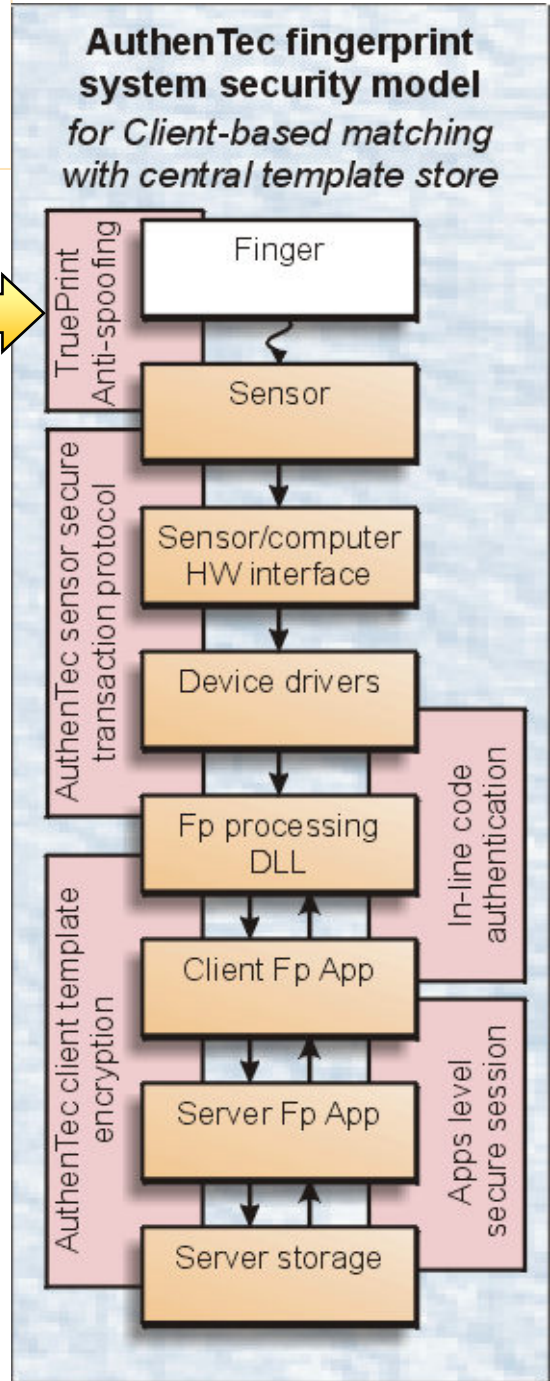
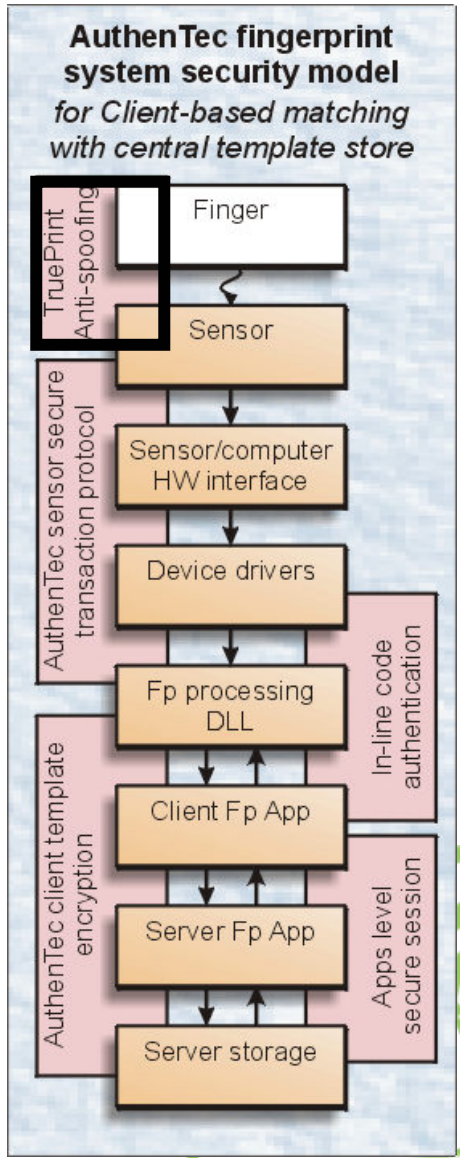
Interlocked component security architecture

- Security starts at the finger-to-sensor interface
  - Spoof detection mechanisms reject fake fingers
- Sensor uses a secure transaction protocol to authenticate each message
  - Uses an on-chip digital signature engine
- Code signing and authentication prevent Software tampering
- Multi-level template encryption and authentication prevent substitutions or insertions
- System level session security links users to privileges



Fake Finger Rejection

- **Definitions:**
  - Fake Finger Rejection = Ability to detect and reject artificial replicas of real fingers
  - Fingerprint pattern data must be treated as publicly available
- **Importance:**
  - Not important in older criminology and background checking applications
    - Use of fake fingers is impractical where sensor use is heavily supervised
  - Critical importance in emerging unsupervised applications
    - E-commerce, E-Banking, general password replacement
    - Personal portable device protection



Biometric Anti-spoofing Approaches

- Class 1. Generic properties of real biometric structures
  - Static properties
  - Dynamic properties
- Class 2. Properties of the real biometric structure that are somewhat specific to the individual
  - Static properties
  - Dynamic properties
- Class 3. Low-selectivity secondary biometric patterns of the structure
  - Static properties
  - Dynamic properties

Skin optical transparency

Cardiac pulse

User specific skin optical transparency

Cardiac pressure profiles

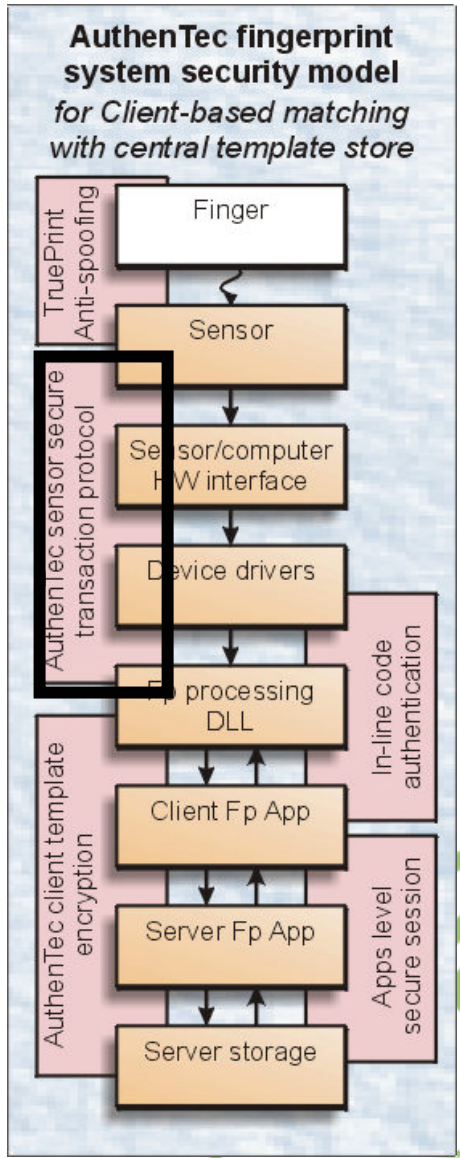
Spectral or spatial pattern of skin optical transparency

Simultaneous Multi-biometric measurements

- Class 3 anti-spoofing
  - Utilize low-selectivity secondary biometric properties
- In fingerprint sensors, Measure multiple biometric properties of the finger
  - Fingerprint PLUS other properties
  - **Characteristics of the best biometric properties:**
    - Unrelated to friction ridge pattern (biometrically orthogonal)
    - Cannot be deduced from info in a latent fingerprint
    - Somewhat different from one person to the next
    - Reasonably uniform distribution across the population
    - Somewhat stable for a single finger over time
- Characteristics of the measurements
  - Measurements made simultaneously
  - Measure the same physical structure
  - Use colocated sensing devices

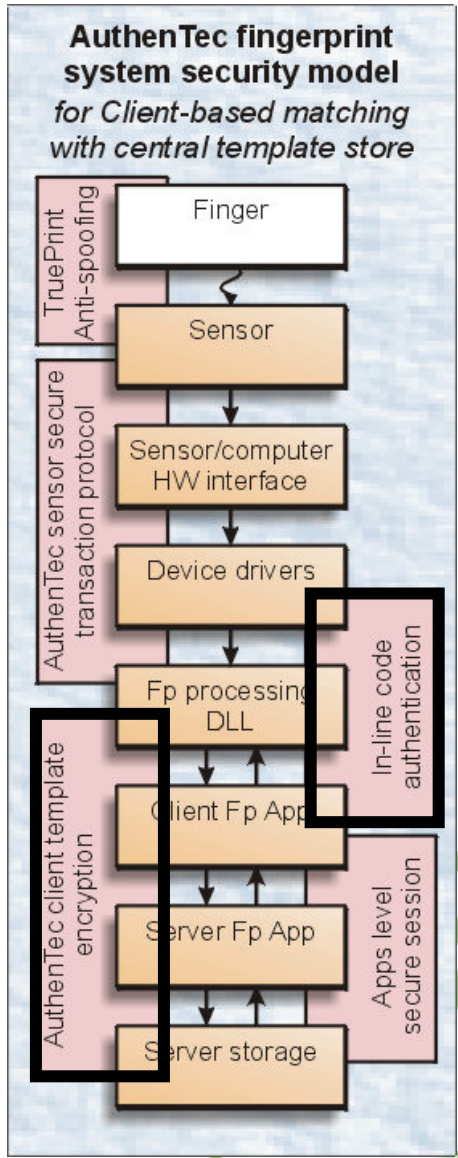
Sensor Secure Transaction Protocol

- Protects against
  - Threats to the “wire” between the sensor and the host computer
  - Attacks on the I/O drivers or device drivers
  - Including: record/replay, man-in-the-middle, device substitution, etc
- Protocol overview
  - The processor sends a new challenge word to the sensor before each image is captured
  - The challenge word is used with codes internal to the sensor to produce an encryption key
  - Each image is digitally signed using the image data and this encryption key
  - Each image’s signature is verified when that image is processed



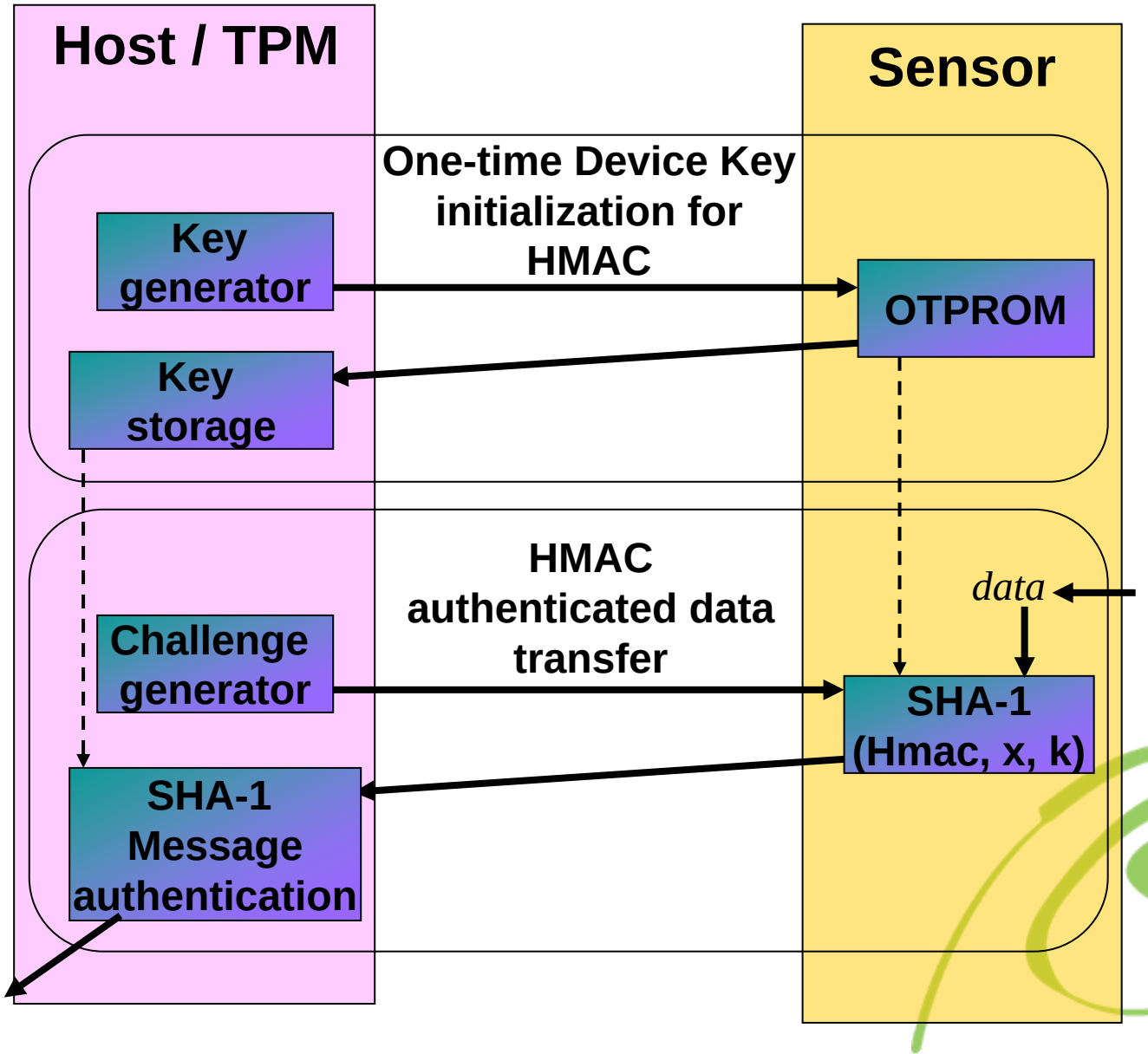
Securing the software services

- Objective
  - Make the software and data as secure as practical
    - Within the limits of current commercial platforms
  - Architecture must provide clean transition path
    - Provide reasonable security on existing platforms
    - Support TPM services where available
    - Support trusted platform
      - when infrastructure support becomes available



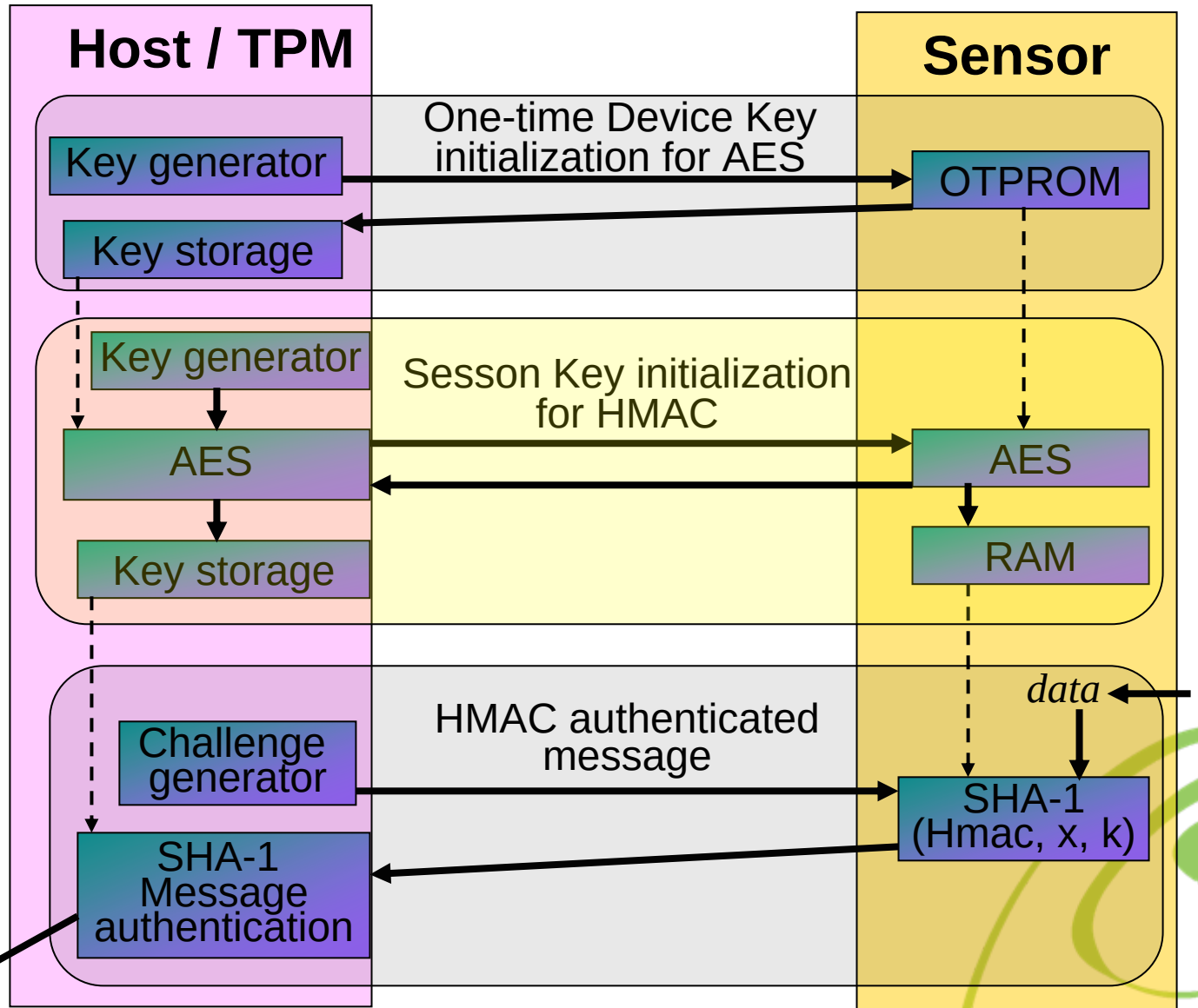
Example minimum stationary input device transactions

- Sensor key init
  - performed in secure environment
  - Either during:
    - Mfg. init.
    - Sys Mgr config
    - Initial user enroll
- Trusted device is
  - Combo of periph. device + TPM
  - For remote usage, TPM rehashes and then signs data
    - Allows device key to remain local
  - Key mgmt with the remote server via TPM PKI



Session keys for stationary input device

- Session key initialization
  - Add a third transaction type for session key init
  - performed every time device is powered up
- Trusted device is
  - Combo of peripheral device + TPM
  - Session keys can be generated remotely and used for verification remotely (e.g. MS server)
  - No rehashing by the TPM is required
  - Key mgmt with server via TPM PKI



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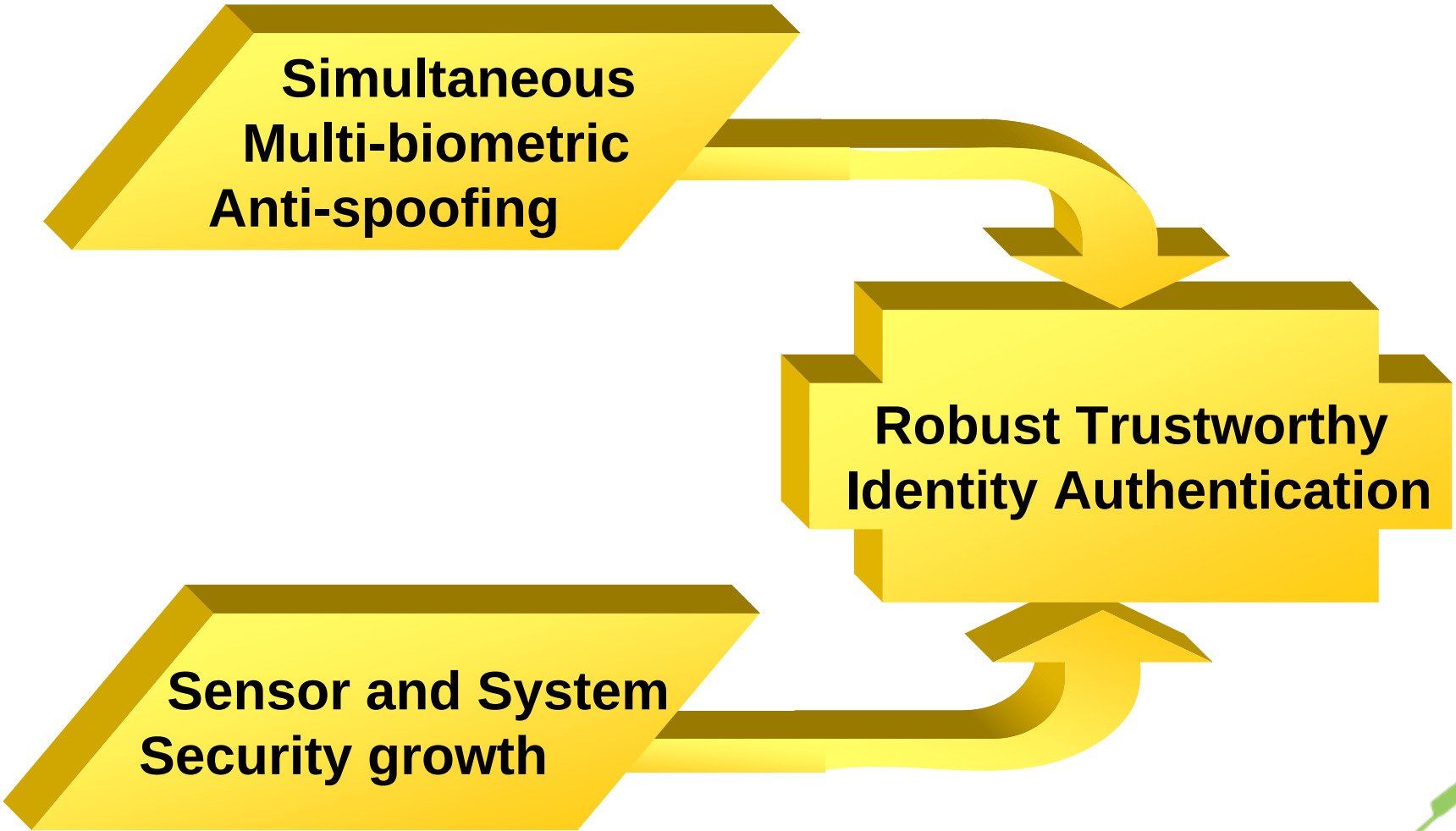
Putting It All Together



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